

CLAIMS

What is claimed is:

1 1. A method performed by a first computer node for selecting a leader node to provide
2 service to a plurality of other nodes in a multicast group, wherein each of the nodes
3 communicates using multicast, broadcast or anycast messages, the method comprising the
4 computer-implemented steps of:
5 issuing a first election call message;
6 receiving candidacy announcement messages from one or more leader candidate
7 nodes in a specified time period;
8 selecting a victor from among all leader candidate nodes from which candidacy
9 announcement messages are received;
10 receiving one or more victor announcement messages from one or more leader victor
11 nodes for a second specified time period;
12 resolving zero or more collisions among the victor announcement messages to result
13 in selecting the leader node.

1 2. A method as recited in Claim 1, wherein the leader node is a key server that provides
2 keys for use in encrypting multicast group messages.

1 3. A method as recited in Claim 1, wherein the leader node is a GDOI key server that
2 provides keys to nodes according to Group Domain of Interpretation.

1 4. A method as recited in Claim 1, further comprising:
2 performing a coin toss operation that results in either a first result or a second result;
3 and
4 sending a candidacy announcement message in response to the first result occurring,
5 or awaiting the candidacy announcement messages from the one or more
6 leader candidate nodes in response to the second result occurring.

- 1 5. A method as recited in Claim 1, wherein the step of selecting a victor further
2 comprises the steps of:
3 determining whether the first computer node is the winner; and
4 sending a victor announcement message in response to determining that the first
5 computer node is the winner.
- 1 6. A method as recited in Claim 1, further comprising the step of ignoring any election
2 call messages while awaiting receipt of the one or more candidacy announcement messages.
- 1 7. A method as recited in Claim 1, wherein selecting a victor comprises selecting one of
2 the leader candidate nodes having a highest network address.
- 1 8. A method as recited in Claim 1, wherein resolving any collisions comprises:
2 determining that two or more announcement messages have been received; and
3 issuing a second election call message.
- 1 9. A method as recited in Claim 1, wherein the election call message, candidacy
2 announcement messages, and victor announcement messages are multicast, broadcast or
3 anycast messages.
- 1 10. A method as recited in Claim 1, further comprising the steps of:
2 receiving, in the first election call message, first identity information specifying a
3 second node that sent the first election call message;
4 pushing the identity information onto a stack;
5 receiving a second election call message that includes second identity information
6 specifying a third node that sent the second election call message; and
7 ignoring the second election call message when the second identity information is
8 found in the stack.

1 11. A method as recited in Claim 1, wherein each of the messages comprises a packet
2 type value, sender sequence number value, sender identity value, and a digital signature of a
3 node that sent the message.

1 12. A method as recited in Claim 1, further comprising digitally signing each of the
2 messages.

1 13. A method as recited in Claim 1, further comprising the steps of:
2 creating a sequence number for each message that is sent;
3 digitally signing each message before sending the message; and
4 incrementing the sequence number.

1 14. A method as recited in Claim 1, wherein the step of issuing the first election call
2 message is performed only after failing to receive a reply to a key server discovery message
3 that is sent by the first node upon newly joining a multicast group.

1 15. A method as recited in Claim 1, wherein the first node is a member of an ad hoc
2 multicast group.

1 16. A method performed by a first computer node for selecting a Group Domain of
2 Interpretation (GDOI) key server to provide key service to a plurality of client nodes in a
3 multicast group, the method comprising the computer-implemented steps of:
4 issuing a first election call message;
5 receiving candidacy announcement messages from one or more leader candidates in a
6 specified time period;
7 selecting a winner from among all leader candidates from which candidacy
8 announcement messages are received;
9 receiving one or more victor announcement messages from one or more leader victor
10 nodes for a second specified time period;

11 resolving zero or more collisions among the victor announcement messages to result
12 in selecting the leader node;
13 wherein the election call message, candidacy announcement messages, and victor
14 announcement messages are multicast, broadcast or anycast messages.

1 17. A method as recited in Claim 16, further comprising the steps of:
2 receiving, in the first election call message, first identity information, specifying a
3 second node that sent the first election call message;
4 pushing the identity information onto a stack;
5 receiving a second election call message that includes second identity information
6 specifying a third node that sent the second election call message; and
7 ignoring the second election call message when the second identity information is
8 found in the stack.

1 18. A method as recited in Claim 16, wherein the step of issuing the first election call
2 message is performed only after failing to receive a reply to a key server discovery message
3 that is sent by the first node upon newly joining a multicast group.

1 19. A method as recited in Claim 16, further comprising:
2 performing a coin toss operation that results in either a first result or a second result;
3 and
4 sending a candidacy announcement message in response to the first result occurring,
5 or awaiting the candidacy announcement messages from the one or more
6 leader candidates in response to the second result occurring.

1 20. A method as recited in Claim 16, wherein the step of selecting a winner further
2 comprises the steps of:
3 determining whether the first computer node is the winner; and
4 sending a victor announcement message in response to determining that the first
5 computer node is the winner.

1 21. A method as recited in Claim 16, further comprising the step of ignoring any election
2 call messages while awaiting receipt of the one or more candidacy announcement messages.

1 22. A method as recited in Claim 16, wherein selecting a winner comprises selecting one
2 of the leader candidates having a highest network address.

1 23. A method as recited in Claim 16, wherein resolving any collisions comprises:
2 determining that two or more announcement messages have been received; and
3 issuing a second election call message.

1 24. A method as recited in Claim 16, wherein each of the messages comprises a packet
2 type value, sender sequence number value, sender identity value, and a digital signature of a
3 node that sent the message.

1 25. A method as recited in Claim 1, further comprising the steps of:
2 creating a sequence number for each message that is sent;
3 digitally signing each message before sending the message; and
4 incrementing the sequence number.

1 26. A method as recited in Claim 1, wherein the first node is a member of an ad hoc
2 multicast group.

1 27. A computer-readable medium carrying one or more sequences of instructions for a
2 first computer node for selecting a leader node to provide service to a plurality of other nodes
3 in a multicast group, wherein each of the nodes communicates using multicast, broadcast or
4 anycast messages, which instructions, when executed by one or more processors, cause the
5 one or more processors to carry out the steps of:
6 issuing a first election call message;

7 receiving candidacy announcement messages from one or more leader candidate
8 nodes in a specified time period;
9 selecting a victor from among all leader candidate nodes from which candidacy
10 announcement messages are received;
11 receiving one or more victor announcement messages from one or more leader victor
12 nodes for a second specified time period;
13 resolving zero or more collisions among the victor announcement messages to result
14 in selecting the leader node.

1 28. A computer-readable medium as recited in Claim 27, wherein the leader node is a key
2 server that provides keys for use in encrypting multicast group messages.

1 29. A computer-readable medium as recited in Claim 27, wherein the leader node is a
2 GDOI key server that provides keys to nodes according to Group Domain of Interpretation.

1 30. A computer-readable medium as recited in Claim 27, further comprising instructions
2 for:
3 performing a coin toss operation that results in either a first result or a second result;
4 and
5 sending a candidacy announcement message in response to the first result occurring,
6 or awaiting the candidacy announcement messages from the one or more
7 leader candidate nodes in response to the second result occurring.

1 31. A computer-readable medium as recited in Claim 27, wherein the instructions for the
2 step of selecting a victor further comprise instructions for the steps of:
3 determining whether the first computer node is the winner; and
4 sending a victor announcement message in response to determining that the first
5 computer node is the winner.

1 32. A computer-readable medium as recited in Claim 27, further comprising instructions
2 for the step of ignoring any election call messages while awaiting receipt of the one or more
3 candidacy announcement messages.

1 33. A computer-readable medium as recited in Claim 27, wherein selecting a victor
2 comprises selecting one of the leader candidate nodes having a highest network address.

1 34. A computer-readable medium as recited in Claim 27, wherein resolving any collisions
2 comprises:
3 determining that two or more announcement messages have been received; and
4 issuing a second election call message.

1 35. A computer-readable medium as recited in Claim 27, wherein the election call
2 message, candidacy announcement messages, and victor announcement messages are
3 multicast, broadcast or anycast messages.

1 36. A computer-readable medium as recited in Claim 27, further comprising instructions
2 for the steps of:
3 receiving, in the first election call message, first identity information specifying a
4 second node that sent the first election call message;
5 pushing the identity information onto a stack;
6 receiving a second election call message that includes second identity information
7 specifying a third node that sent the second election call message; and
8 ignoring the second election call message when the second identity information is
9 found in the stack.

1 37. A computer-readable medium as recited in Claim 27, wherein each of the messages
2 comprises a packet type value, sender sequence number value, sender identity value, and a
3 digital signature of a node that sent the message.

1 38. A computer-readable medium as recited in Claim 27, further comprising digitally
2 signing each of the messages.

1 39. A computer-readable medium as recited in Claim 27, further comprising instructions
2 for the steps of:
3 creating a sequence number for each message that is sent;
4 digitally signing each message before sending the message; and
5 incrementing the sequence number.

1 40. A computer-readable medium as recited in Claim 27, wherein the step of issuing the
2 first election call message is performed only after failing to receive a reply to a key server
3 discovery message that is sent by the first node upon newly joining a multicast group.

1 41. A computer-readable medium as recited in Claim 27, wherein the first node is a
2 member of an ad hoc multicast group.

1 42. An apparatus for a first computer node for selecting a leader node to provide service
2 to a plurality of other nodes in a multicast group, wherein each of the nodes communicates
3 using multicast, broadcast or anycast messages, comprising:
4 means for issuing a first election call message;
5 means for receiving candidacy announcement messages from one or more leader
6 candidate nodes in a specified time period;
7 means for selecting a victor from among all leader candidate nodes from which
8 candidacy announcement messages are received;
9 means for receiving one or more victor announcement messages from one or more
10 leader victor nodes for a second specified time period;
11 means for resolving zero or more collisions among the victor announcement
12 messages to result in selecting the leader node.

1 43. An apparatus as recited in Claim 42, wherein the leader node is a key server that
2 provides keys for use in encrypting multicast group messages.

1 44. An apparatus as recited in Claim 42, wherein the leader node is a GDOI key server
2 that provides keys to nodes according to Group Domain of Interpretation.

1 45. An apparatus as recited in Claim 42, further comprising:
2 means for performing a coin toss operation that results in either a first result or a
3 second result; and
4 means for sending a candidacy announcement message in response to the first result
5 occurring, or awaiting the candidacy announcement messages from the one or
6 more leader candidate nodes in response to the second result occurring.

1 46. An apparatus as recited in Claim 42, wherein the means for selecting a victor further
2 comprises:
3 means for determining whether the first computer node is the winner; and
4 means for sending a victor announcement message in response to determining that the
5 first computer node is the winner.

1 47. An apparatus as recited in Claim 42, further comprising means for ignoring any
2 election call messages while awaiting receipt of the one or more candidacy announcement
3 messages.

1 48. An apparatus as recited in Claim 42, wherein the means for selecting a victor
2 comprises means for selecting one of the leader candidate nodes having a highest network
3 address.

1 49. An apparatus as recited in Claim 42, wherein the means for resolving any collisions
2 comprises:
3 means for determining that two or more announcement messages have been received;
4 and
5 means for issuing a second election call message.

1 50. An apparatus as recited in Claim 42, wherein the election call message, candidacy
2 announcement messages, and victor announcement messages are multicast, broadcast or
3 anycast messages.

1 51. An apparatus as recited in Claim 42, further comprising the steps of:
2 means for receiving, in the first election call message, first identity information
3 specifying a second node that sent the first election call message;
4 means for pushing the identity information onto a stack;
5 means for receiving a second election call message that includes second identity
6 information specifying a third node that sent the second election call message;
7 and
8 means for ignoring the second election call message when the second identity
9 information is found in the stack.

1 52. An apparatus as recited in Claim 42, wherein each of the messages comprises a
2 packet type value, sender sequence number value, sender identity value, and a digital
3 signature of a node that sent the message.

1 53. An apparatus as recited in Claim 42, further comprising means for digitally signing
2 each of the messages.

1 54. An apparatus as recited in Claim 42, further comprising:
2 means for creating a sequence number for each message that is sent;

3 means for digitally signing each message before sending the message; and
4 means for incrementing the sequence number.

1 55. An apparatus as recited in Claim 42, further comprising means for issuing the first
2 election call message only after failing to receive a reply to a key server discovery message
3 that is sent by the first node upon newly joining a multicast group.

1 56. An apparatus as recited in Claim 42, wherein the first node is a member of an ad hoc
2 multicast group.

1 57. An apparatus for a first computer node for selecting a leader node to provide service
2 to a plurality of other nodes in a multicast group, wherein each of the nodes communicates
3 using multicast, broadcast or anycast messages, comprising:
4 a network interface that is coupled to the data network for receiving one or more packet
5 flows therefrom;
6 a processor;
7 one or more stored sequences of instructions which, when executed by the processor, cause
8 the processor to carry out the steps of:
9 issuing a first election call message;
10 receiving candidacy announcement messages from one or more leader candidate
11 nodes in a specified time period;
12 selecting a victor from among all leader candidate nodes from which candidacy
13 announcement messages are received;
14 receiving one or more victor announcement messages from one or more leader victor
15 nodes for a second specified time period;
16 resolving zero or more collisions among the victor announcement messages to result
17 in selecting the leader node.

1 58. An apparatus as recited in Claim 57, wherein the leader node is a key server that
2 provides keys for use in encrypting multicast group messages.

1 59. An apparatus as recited in Claim 57, wherein the leader node is a GDOI key server
2 that provides keys to nodes according to Group Domain of Interpretation.

1 60. An apparatus as recited in Claim 57, the sequences of instructions further comprising
2 instructions for:
3 performing a coin toss operation that results in either a first result or a second result;
4 and
5 sending a candidacy announcement message in response to the first result occurring,
6 or awaiting the candidacy announcement messages from the one or more
7 leader candidate nodes in response to the second result occurring.

1 61. An apparatus as recited in Claim 57, wherein the step of selecting a victor further
2 comprises the steps of:
3 determining whether the first computer node is the winner; and
4 sending a victor announcement message in response to determining that the first
5 computer node is the winner.

1 62. An apparatus as recited in Claim 57, the sequences of instructions further comprising
2 instructions for ignoring any election call messages while awaiting receipt of the one or more
3 candidacy announcement messages.

1 63. An apparatus as recited in Claim 57, wherein selecting a victor comprises selecting
2 one of the leader candidate nodes having a highest network address.

1 64. An apparatus as recited in Claim 57, wherein resolving any collisions comprises:
2 determining that two or more announcement messages have been received; and
3 issuing a second election call message.

1 65. An apparatus as recited in Claim 57, wherein the election call message, candidacy
2 announcement messages, and victor announcement messages are multicast, broadcast or
3 anycast messages.

1 66. An apparatus as recited in Claim 57, the sequences of instructions further comprising
2 instructions for:
3 receiving, in the first election call message, first identity information specifying a
4 second node that sent the first election call message;
5 pushing the identity information onto a stack;
6 receiving a second election call message that includes second identity information
7 specifying a third node that sent the second election call message; and
8 ignoring the second election call message when the second identity information is
9 found in the stack.

1 67. An apparatus as recited in Claim 57, wherein each of the messages comprises a
2 packet type value, sender sequence number value, sender identity value, and a digital
3 signature of a node that sent the message.

1 68. An apparatus as recited in Claim 57, the sequences of instructions further comprising
2 instructions for digitally signing each of the messages.

1 69. An apparatus as recited in Claim 57, the sequences of instructions further comprising
2 instructions for the steps of:
3 creating a sequence number for each message that is sent;
4 digitally signing each message before sending the message; and
5 incrementing the sequence number.

1 70. An apparatus as recited in Claim 57, wherein the sequences of instructions for issuing
2 the first election call message are performed only after failing to receive a reply to a key
3 server discovery message that is sent by the first node upon newly joining a multicast group.

1 71. An apparatus as recited in Claim 57, wherein the first node is a member of an ad hoc
2 multicast group.